Aerial Navigation in Warfare

By
Major Charles H. Mitchell,
Corps of Guides, Canada.

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The following Paper was prepared at the request of the Chief of the General Staff, and read by the writer before the Corps of Guides, at Ottawa, Canada, on February 24th, 1911.

That in the warfare of the future Aerial Navigation will play a very important part no one now doubts for a moment. The recent wonderful activity not only in the development but in the operation of air craft has demonstrated that before long an aerial navy will be just as much a part of a nation's war equipment as its marine navy.

The use of air craft in warfare is not by any means new for as long ago as 50 years in the American Civil War stationary balloons were used for reconnaissance, and in all the wars of magnitude since that time the balloon has been freely used. Among the equipment of all modern armies at the present day the balloon divisions of the Engineer Services form a most important part and are actively employed in all training operations. It is not, however, to this class of aerial navigation that our attention is now being drawn, for in point of fact such use of balloons is really not aerial navigation at all, because in nearly all instances such balloons have been stationary and captive and in no case, so far as the writer knows, have they been self propelled.

It is convenient to distinguish between the various classes of air craft according to their nature and functions. The most recent classification is about as follows:—

I. Craft lighter than air: "Aerostatic."

1. Kites—
   - Simple.
   - Man-lifting kites.
   - Balloon kites.

2. Balloons—
   - Captive.
   - Free.

3. Dirigible balloons—
   - Non-rigid types.
   - Semi-rigid types.
   - Rigid types.

II. Craft heavier than air: "Aerodynamic."
   1. Aeroplanes—
      Monoplanes.
      Bi-planes.
   2. Helicopteres—
      Vertical lift machines.
   3. Combined dirigibles and aeroplanes.

While the main attention herein is given to dirigible balloons and to craft which are heavier than air, a few words may be said in passing with regard to the employment of kites and captive balloons, especially in warfare.

Kites.

Kites have been developed considerably in the British Army and Navy and on account of their cheapness and compact form for transportation, have produced very good results in the field. It appears that man-lifting kites have been very successfully operated from ships and lately Major Baden-Powell has worked out a system for using explosive kites against air ships. The man-lifting balloon kite, which is a combination of a small gas-bag and a second bag open freely to the air, has been developed considerably by the Germans, and has been used extensively in their manoeuvres.

Captive Balloons.

The captive balloon is, of course, familiar to all for purposes of general observation, signalling, directing gun fire and, recently, at sea, for the detection of submarine attack. It would appear that notwithstanding the rapid introduction of aeroplanes and dirigibles the captive balloon and kite will still remain a useful means of observation both on land and sea for some time to come.

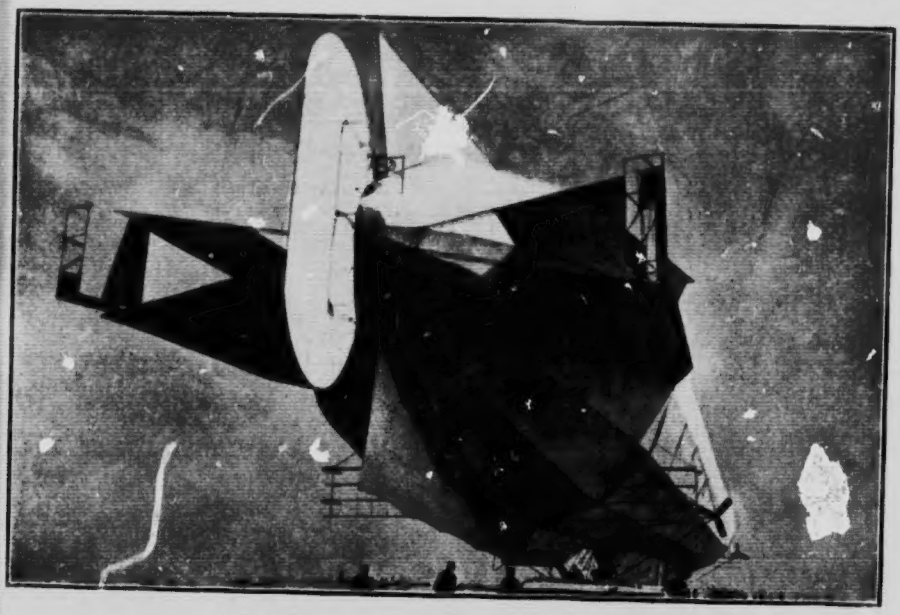
Dirigible Balloons.

Although many early attempts were made to propel balloons, no real success was made until the recent development of the light, but powerful automobile engine. After types of these engines became established their various applications to aerial navigation was most quickly taken advantage of with the recent remarkable results.

A German named Schwartz is credited with driving the first rigid airship with a gasoline motor, which was 12 h.p. His ship, however, was wrecked after several successful trials. This was in 1897. In 1898 Count Zeppelin came on the scene with a rigid type, having an aluminum frame and gas bags between an inner and outer envelope—built in gas-proof compartments

as it were. It was a large vessel 300 feet long, driven with two gasoline motors, each geared to two propellers. Though he secured a still air speed of 16 miles per hour, there were many defects found and the attempt was temporarily given up, but patriotic Germans came forward in these discouraging days with money to build a second.

In 1902 Santos Dumont, in a non-rigid cigar-shaped balloon, performed the first really signal dirigible feat by circling around the Eiffel Tower in Paris, winning a prize of $20,000. This year also saw the first work of the Lebaudy brothers, who brought out a semi-rigid type by which the bending and buckling strains are taken off the gas envelope by a metallic keel; this was propelled by a 35 h.p. motor. This vessel was wrecked



ZEPPELIN IV. DIRIGIBLE BALLOON

Courtesy John Lane Co., from "Airships in Peace and War," *Hearne.*

in 1903 after doing some 50 successful trips, the longest being 62 miles at 22 miles per hour average. But this was the start of the great French airship fleet, for shortly afterwards the French Army adopted a similar type, and after several successful ships, the "Patrie" was launched in 1906, and in 1907 was used in the manoeuvres, doing a trip from Paris to the frontier, a distance of 150 miles, at 22 miles per hour. Shortly after, however, the "Patrie" was wrenched from her moorings, blown away and lost on the North Atlantic. This was followed by the "Republique," the largest of the semi-rigid type yet built, having cylindrical stablizing gas bags at the stem; she was 210 feet long, had an 80 h.p. engine, a range of action of 500 miles

and could carry nine men. In 1908 she did 147 miles at 21 miles per hour.

In the meantime Count Zeppelin had succeeded in his second ship, which was tested in 1906, but was wrecked by a storm. This was shortly followed by a third, and in 1908, by a fourth much more powerful than its predecessors. This "Zeppelin IV." was built on special specifications of carrying power, speed, endurance; she was 446 feet long, had two Mercedes motors of 120 h.p. each, carried a crew of 18 men, and her estimated range of action was 800 miles. One special feature was the arrangement of the 16 independent gas bags within the envelope. This airship was tried out in numerous preparatory short trips before the official government trial, by which the airship was to carry 16 men and be capable of travelling for 24 hours. In one of these trials in June, 1908, "Zeppelin IV." went across the Alps, doing in 12 hours a total of 270 miles at an average speed of 22 miles. In August of the same year an eventful attempt in which the ship again travelled a distance of 270 miles at an average of 24 miles per hour, resulted in its complete wreck by explosion and fire; this accident could not have occurred, it is said, had there been apparatus for properly anchoring the vessel to the ground while at rest.

The same year two other successful German dirigible airships, the "Gross" and the "Parseval," both military ships, made their appearance, the former remaining aloft for 13 hours, and reaching an altitude of 4,000 feet, and the latter for 12 hours.

In 1909 dirigible airships of the foregoing types performed many successful and extraordinary flights. France put four notable new ships out—similar to the "Republique." The latter vessel, while going to the French Army manoeuvres, met with an accident which was promptly repaired by the Airship Corps of their army in the field under virtual war conditions. This field repair marked a new step in progress. The ship was used in the manoeuvres and did very useful intelligence work, particularly discovering a wide turning movement of its opponents. The "Republique" was completely wrecked by the breaking of a steel propeller blade in September, and the crew of four killed.

In Germany 1909 saw remarkable performances of the new Zeppelin's, the "Gross" and the "Parseval." The former made a round trip of 800 miles, including the sailing over Berlin, and this placed the Zeppelin far ahead of all rivals. The work of four airships at the German military manoeuvres that year was extensive, and though no information was given out it is known from attaches' reports that exceedingly useful work was accomplished. One interesting operation was a night attack against the fortress of Ehrenbreitstein on the Rhine near Coblenz, in which several ships were employed.

During the year 1909 a new Italian airship in a run of 190

miles made 27 miles per hour average, which captured the high speed record.

The year 1910 produced some new records of particular interest, and there were several notable flights of historic value. Wellman made a courageous attempt to cross the Atlantic, starting near Boston. His arrangement, which he called an "equilibrator," which dragged in the water to stabilize the ship, nearly caused a fatal ending; as it was, the ship was blown about and out of its course by a fierce gale, and was finally abandoned about 200 miles at sea, the crew being taken off by a steamer under thrilling circumstances. The French dirigible, "Clement Bayard II.," made a remarkable flight from Paris to London on October 16th, doing 246 miles at an average of 41 miles per hour, with a crew of seven men. This airship is 251 feet long, 44 feet diameter, has two engines of 120 h.p. each, a range of 750 miles, and carrying a capacity of 20 men.

Dirigibles were used in the principal European Army manoeuvres in 1910, with varying success. In this connection the great success of the British dirigible, the little "Beta," is of interest because of the plucky work of its commander. It is just announced that this airship, working near Aldershot this week, kept in touch by wireless during the whole of a trip of many miles from start to finish.

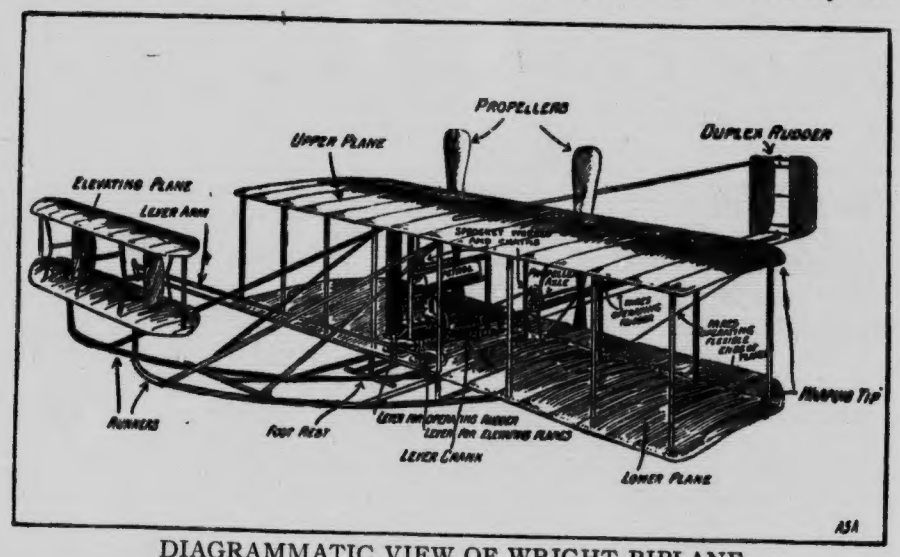
On February 7th, 1911, the German dirigible, "Gross IV.," was taken out for its first trial. It is 344 feet long and expected to be one of the fastest yet constructed, being capable of making 40 miles per hour. The British admiralty, however, has just now (February 18th) about completed a monster airship—the first aerial "Dreadnought"—at Barrow-in-Furness, 510 feet long, 48 feet diameter, and having 706,000 cubic feet capacity; eight cylinder motors, with three new type propellers are expected to drive the ship at 50 miles per hour.

Aeroplanes.

The perfecting and the employment of aeroplanes is much more recent than the similar progress with dirigible balloons. The early experimenting and research, however, commenced about 1892, and by 1896 there was considerable data and some experience accumulated with respect to bird-flight, gliding on air and laboratory aero-dynamics. The outstanding features of this period were the experiments with kites by Professor Langley in America, the construction of a steam-driven aeroplane by Sir Hiram Maxim in England, and the actual air-gliding by Lilienthal in Germany. With the latter's death and

the great difficulties encountered by Maxim, progress almost ceased, and for a period of eight years the only work done was quiet experimenting in seeking after suitable engines, propellers and forms for aeroplanes. Chief among these workers were the Wright brothers, who, for some years prior to 1904, were working with one and two-plane gilders in North Carolina at a place where among rolling sand dunes a steady wind was assured. In this work they were assisted on the technical side by the late Mr. Octave Chanute, an eminent consulting engineer of Chicago. In such a manner they became expert in the handling of their air craft.

At this period —1905—several forms of aeroplanes had become notable, and with the solution of the engine problem following closely on the development of the automobile engine actual flights were accomplished. There remained, however, the perfecting of innumerable details and the gaining of experience and skill on the part of operators to attain the confidence, presence of mind, and almost intuitive quickness necessary to



DIAGRAMMATIC VIEW OF WRIGHT BIPLANE

Courtesy John Lane Co., from "Airships in Peace and War," *Hearne.*

control a heavier than air machine in much the same way as the learning to ride a bicycle. These early experiments of either gliding or driving a plane against the air for a short distance were based upon the principles of soaring bird-flight or of the skater on thin ice.

In 1905 the Wrights astonished the world with the announcement, without details, that their bi-plane machine had actually remained in the air for a half-hour, and later that they had flown 24 miles in 38 minutes. In other flights they had attained great speed, the greatest having been 38 miles per hour.

As the Wrights undoubtedly led the world in the development and operation of their aeroplane, there are several features of the machine deserving of special mention here. The frame was of hickory and the planes of strong fabric; the wing warping device on the corners of the planes, worked by wires over pulleys for balancing and facilitating turning, were especially novel. This flexure of planes in conjunction with vertical and horizontal rudders enabled the balance to be quickly —almost instinctively—made. By their long experience in these early days the Wrights became so dexterous that they were for some years far ahead of other aviators in their skill in flying. They showed that it was more in the man than in the machine that success lay.

In 1907 a new aviator, Farman, appeared in France, and he accomplished numerous short flights, up to a half-mile, in a bi-plane, known then as the "Voisin." His performances, however, were soon eclipsed by those of Delagrange, another Frenchman, who, in 1908, flew various distances up to 15 miles, done on September 6th. But this month of September, 1908, was destined to become notable in aviation, as the Wrights, one in Europe, and one at Fort Meyer, in the United States, were almost daily performing something new, the one breaking the record of the other. The performances comprised flights of over an hour by Orville Wright in America on September 9th and 12th; in the latter 45 miles were covered. Wilbur Wright in Europe on September 21st, flew one hour and a half, in which 56 miles were done and on September 28th, he carried a passenger.

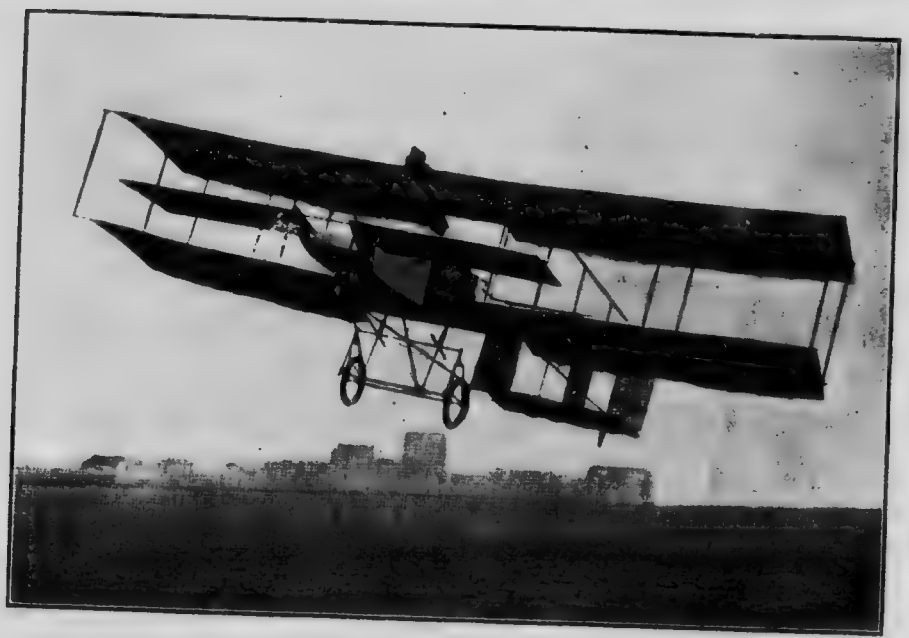
In October of 1908 Wilbur Wright, with a passenger, did 36 miles in 56 minutes, and Bleriot first appeared with his small monoplane, in which he did 3 miles in four minutes and a half.

The year 1909 was notable in aeroplane performances as well as for dirigible balloons. Orville Wright carried a passenger 45 miles in one hour and thirteen minutes on July 22nd, and three days later the world was startled by the news that Bleriot had boldly crossed the English Channel in a small monoplane, 31 miles in 40 minutes. Then on August 26th, Latham, a new aviator, with an Antionette monoplane, flew 97 miles in 2 hours and 13 minutes, and the following day Farman, again to the front, with his bi-plane, broke all records by going 112 miles without a stop. Again on November 3rd, 1909, Farman in his own bi-plane with a Gnome motor, flew 145 miles in 4 hours and 18 minutes. Another significant performance by Farman was on August 28th, when he carried two passengers 6 miles in ten and a half minutes.

This year a second American aviator came prominently before the world; this was Curtiss who, in a bi-plane of his own design performed various feats, especially at the

time of the Fulton celebration at New York. His machine, developed with the advice of Dr. Graham Bell, is, in general, similar to the Wrights, but instead of warping the ends of planes, he has small auxiliary planes at the outside ends between the two main ones; his manipulation is also interesting, as he employs the shoulders and swaying body in actuating the rudders for horizontal turning. It is in this type of machine (perfected in the Hammondsport Experiments) that J. A. D. McCurdy, of the class of 1907, Engineering, in Toronto University, is now doing such wonderful feats.

The year 1910 did not produce any extraordinarily long flights, but the altitude records were very much increased, about



FARMAN BIPLANE

Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

7,000 feet being the highest. The various aviation meets, notably those at Belmont Park and Atlantic City, brought out results in control and handling of aeroplanes which prove beyond doubt that these machines are capable of various rapid manoeuvres far beyond the earlier expectations, and these are probably only the beginnings, so that we are justified in expecting wonderful results in stability, manoeuvre and carrying power within the next five years. Speeds were also much increased, especially with the monoplanes which are, of course, the fastest types; Morane, with a new Bleriot, flew 66 miles per hour at Rheims.

As examples of manoeuvre in 1910 two performances in

America are notable. One was by Graham White, an English aviator, who flew over the City of Washington, alighted in the street in front of the Navy Headquarters Building, made a call and rose again from the street and flew away again over the city. The other was at Belmont Park, when an aviator, off to a false start on the race course, was recalled and suddenly circled in a small radius around the judges and the announcement board, back to the track in front of the grand stand.

The flight of Chavez in a Bleriot monoplane over the Alps from Switzerland to Italy in September, 1910, is also notable with respect to manoeuvre, as in 25 miles and a rise of 3,000 feet, he encountered all kinds of vertical cross air currents and bitterly cold air off the snow-clad peaks.

It is likely that the next few years will produce aeroplanes of much greater carrying power as well as of greater manoeuvring capabilities. Increases of speeds are also to be expected, especially with the monoplanes. It was announced in 1910 that a new racing Bleriot had been built and was being secretly tried, in which speeds up to 75 miles per hour were expected. This type had ingenious wings, which could be flattened out in mid-air and contracted so that the machine could be speeded up while actually in flight.

Combination Types of Airships.

There is not much yet to be said respecting airships combining the features of balloons and aeroplanes. Several such arrangements have been built and tried, but not worked out over long courses. Vertical lifting machines have also been built, but as yet have not become practical. It is likely, however, that considerable progress will be made within the next few years along the combined lines, especially for meeting conditions where ascents and flights are required to be made irrespective of weather conditions, such as may be absolutely necessary in warfare.

There is no doubt that very shortly a vertical lifting "heavier than air" machine will be brought out, capable of standing stationary, or hovering over any point; this will probably combine the horizontal speed properties of the aeroplane.

A new combination of airship and hydro-plane is also beginning to appear, brought about by the necessity of aeroplanes alighting on or rising from water. Only last month Curtiss, in such a machine at San Diego, Cal., alighted on the water alongside a U. S. warship, and after 15 minutes' visit, rose again from the same spot.

Feasibility of Aerial Navigation.

From the foregoing it is not only apparent that the navigation of the air is feasible by dirigibles and aeroplanes, but that

DETAILS OF AEROPLANE TYPES

(As in use in 1909 and 1910.)

CHARACTERISTICS	MONOPLANES		BIPLANES			
	BLERIOT	ANTIONETTE	WRIGHT	FARMAN	VOISIN	CURTISS
AEROPLANES:—						
Span, feet	28	46	40	33	38	29
Area, sq.ft.	150	377	540	430	540	250
WEIGHT:—(No Pilot)						
Total, pounds	462	1045	880	990	1100	550
Per sq.ft. c. Plane	3.08	2.77	1.63	2.30	2.04	2.20
MOTOR:—						
Type—Cylinders	3	8	4	4	8	8
Revs. per min.	1200	1100	1500	1300	1200	1200
Power in H.P.	24	50	30	50	50	30
Sq.ft. Area per H.P.	6.25	7.50	18.0	8.6	10.8	8.3
Weight per H.P. per sq. ft. Area	0.13	00.5	0.05	0 04	0.04	0.07
PROPELLER:—						
No. of blades	2	2	2 of 2	2	2	2
Material	wood	steel	wood	wood	steel	steel
Diameter	6ft. 9in.	7ft.0in.	8ft.0in.	8ft.6in.	8ft.6in.	6ft.0in.
Speed	1200	1100	450	1300	1200	1200
SPEED:—						
Miles per hour in still air:						
Average	40	38	39	41	37	48

CURTISS BIPLANE USED BY J. A. MCCURDY, '07, (TORONTO UNIVERSITY) Courtesy The Copp, Clark Co., from "Vehicles of the Air." *Lougheed.*

as each year passes, with its improvements in types and increased skill in handling, aerial navigation will, before long, be as assured, and as universal as motoring on land or water It is now only a question of a few years before dirigibles carrying cargoes of many tons, and aeroplanes carrying four or five people will be an established thing. The science will be then beyond the experimental stage and there will be many operators of all nationalities having the requisite experience and skill to actually navigate the air with ease, confidenc and safety.

In view of the present state of the building and skill in flying, we are reasonably justified in expecting that in the next two years:—

Dirigible balloons will have a range of action of 1,000 miles a speed of 40 miles per hour, and a carrying capacity of 4 tons.

Aeroplanes will have a range of action of 200 miles, a speed of 50 miles per hour, and a carrying capacity of 800 pounds.

Both classes of air craft will be capable of operation at will in any moderate wind, either with or against it.

If the foregoing results can be realized the successful permanent employment of such dirigible balloons and aeroplanes for military purposes is an absolute certainty because they are then brought into the category of practical fighting equipment of modern armies and marine navies.

Employment of Airships.

Already, as noted, the great powers have been employing dirigibles and aeroplanes in connection with both army and navy manoeuvres. Just now comes the news that Germany will, in the 1911 manoeuvres to be held on the Baltic coast, use flying machines in connection with combined operations in which the battleship fleet will co-operate with their army corps in problems involving the landing of an army in coastal defence.

In those features of modern war, involving tactics and strategy, the employment of air-craft will entirely revolutionize the science. The application of mounted reconnaissance for both tactical and strategical purposes can be applied equally well to aerial scouting with the addition that the range of action and the horizon will be very much increased.

These general uses will doubtless be extended by the various other services which may be expected of airships—a more complete summary of probable uses may be suggested as follows:—

1. Peace time reconnaisance and study of foreign countries,

fortifications, harbors, etc., by sketching, photographing, etc., in order to familiarize for future use.

2. War time observation, reconnaisance, reporting, etc.

3. Signalling and wireless telegraph purposes.

4. Carrying despatches.

5. Guards and patrols at frontiers and before an army.

6. Preventing an enemy's observation and screening operations from view.

7. Directing and observing artillery fire.

8. Surprise or night attacks.

9. Destroying stores railways or enemy's base or raiding harbors, fortresses or cities.

10. Illuminating enemy's positions at night by searchlights, etc.

11. Discovering, warning of, and destroying submarines and mines.

BLERIOT MONOPLANE

Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

12. In conjunction with general engagements on land or sea.

In order to carry out these various services the peculiar adaptation of dirigible balloons and aeroplanes is very marked; a few of these properties, for war operations, are as follows:—

1. Wide range of action is now obtainable.

2. Carrying capacity is sufficient for men, armament and food, etc.

3. Speed is as fast as any land or sea travel without delays occasioned by latter.

4. Height of operation is such as to be clear of accurate effective gun fire.

5. Direct routes are available day or night, or in fogs (within limits).

6. Positions of altitude are most adapted for observation and signalling, and for locating submarine objects.

7. Air operations cannot be guarded against except with similar craft or by special terrestrial apparatus.

It is evident from the foregoing statements that nearly all classes of air craft will be capable of being successfully and conveniently employed for military purposes. If we are to judge of the probable efficiency of the various craft by the performances of the past few years and look somewhat to the future along the same lines, we can expect the various services to be performed by different kinds of craft in much the same way as are the present naval services. For instance it is reasonable to expect that an organization of air craft for military purposes would probably be made upon such a basis as the following:—

1. Kites of various types for photography and general observation purposes of simple requirements.

2. Captive and free balloons of the types heretofore employed for observation, photography, signalling direction of artillery fire, etc. They could also be used on lines of defence.

3. Aeroplanes of various types for fast scouting and despatch purposes also for rapid attacks on land or naval forces or upon dirigible balloons from above, used much the same as the mosquito fleet on water.

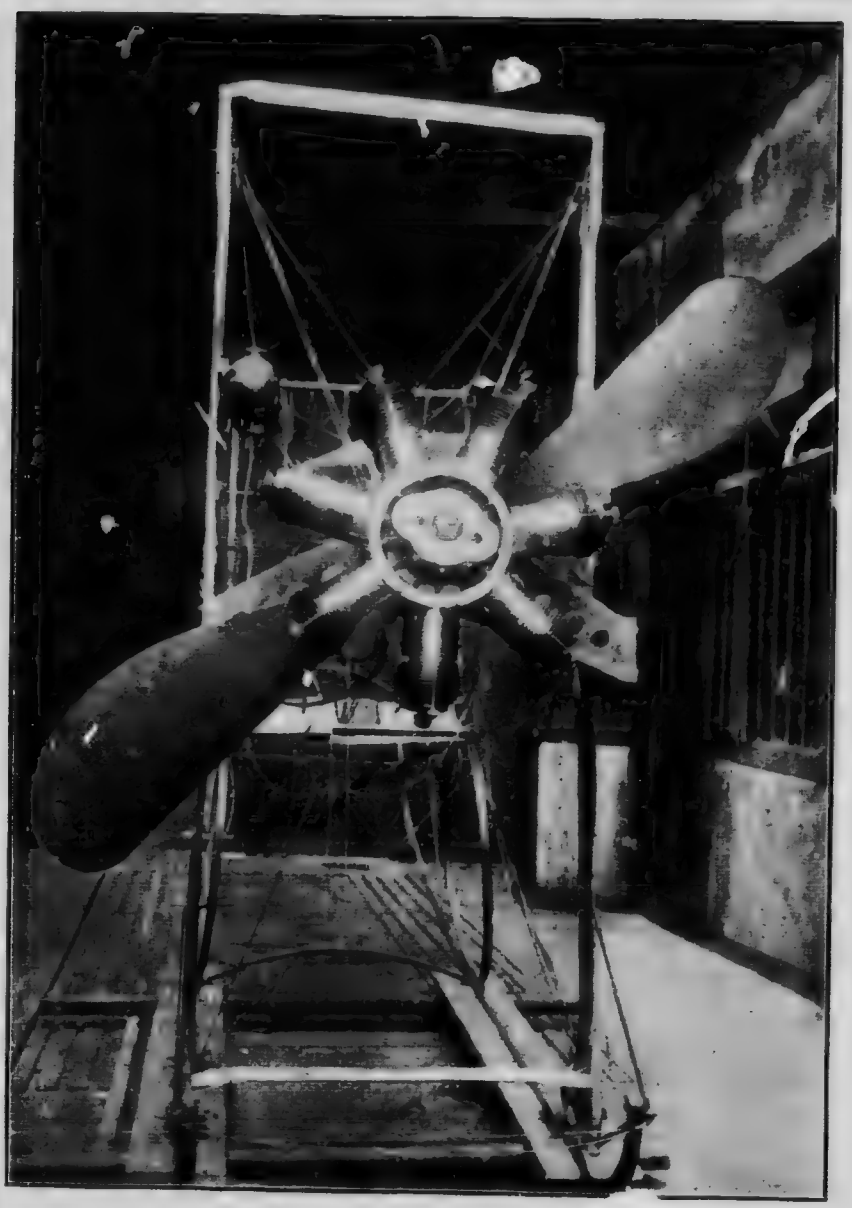
4 Rapidly moving and lightly equipped dirigible balloons being capable of easy and rapid manoeuvre for moderate range of action, both offensive and defensive, in much the same manner as naval cruisers.

5. Heavy, large, high-powered dirigible balloons of wide range of action and with numerous air-tight compartments and with heavy armament for a "first line of battle" employed against either air or marine craft or against land forces.

Operation of Air-Craft.

As to the probable methods of operation of the various types of airships much can be said and conjectured, but until a good many features of endurance, reliability, speed and handling are tried out, it is not likely that definite conclusions can be reached. Even with the more stable types of airship, and in the short years of trial up to the present, the accidents which occurred, and the loss of life, have been appalling. In the year 1910 the number of famous aviators who have lost their lives has been most deplorable, but unfortunately it is to be reasonably expected that there will be still many more accidents and loss of life in the strife for the mastery of the air before the art of building

ships and flying them will become fixed like other similar operations. As, in the nature of events, the "heavier than air" machine is undoubtedly destined to become the ultimate means



GNOME ENGINE AND PROPI
(THE WHOLE REVOLVES AS A FLYWH
Courtesy Crosby, Lockwood & Son, from "The Art of A..ation." *Brewer.*

of aerial locomotion, it is evident that in its development there must yet be years of trial, success and failure before final definite success is attained.

The various difficulties and dangers which have already been encountered are really at the present time increasing rather than being reduced, for as the art advances and navigators become bolder, the hazards taken are greater. For instance, at one time it was thought that navigation in wind and rain storms, fogs, etc., was impossible; now we find ascents being frequently made under such weather conditions as, for example, when Latham in 1909 went 75 miles per hour a gale at Blackpool in his Antoinette monoplane. Fires and explosions on dirigible balloons are a great menace—instance the disaster to Zeppelin IV.—possibly lightning would come also in this category. Breakdown of engine or of propellers or steering gear, etc., in aeroplanes is almost fatal, especially in high flying unless the aviator is successful in righting the machine and gliding to earth without overturning; nearly all fatal aeroplane accidents have been due to this mishap though there are several notable examples of the machine being brought down safely—instance, Curtiss at Atlantic City in 1910. Loss of fuel either by leakage, accident or use is another danger. Collision with buildings, trees or other craft is also to be reckoned with.

In the tactical and strategical employment of air craft it is as yet probably too early in the game to conjecture. The nations which have worked on these lines have been very reticent and jealous of their acquired experience. It is well known, however, that already aerial plans of operations both offensive and defensive, are perfected and filed by several of the European powers with respect to their neighbors. A glance at the map of Europe will show how reasonable it is to expect successful co-operation of aerial craft with army and navy in the case of the several great powers whose capitals, fortresses and naval bases are quite within striking distance of dirigibles and of even the shorter range aeroplanes.

Armament for and Against Airships.

It has not been a mere fanciful conception that balloons and aeroplanes having free approach and "air way" to pass over armies, fortresses, and warships can drop explosives and concentrate destructive fire upon them. It has been found, however, that, though frequently demonstrated, it is really easier said than done. That a large balloon can hover above any point sufficiently steady and sufficiently low to ensure accurate aim is asking much of its mechanism and handling to say nothing of the courage of its crew. Further, to expect a fast moving aeroplane—for it must move at least 20 miles per hour—to drop an explosive or series of them on a given point at a given time is another large order, and, though demonstrated at exhibitions in 1910, would undoubtedly be a very difficult thing to do in service when the machine is a target for various terrestrial ordnance.

It is to be reasonably expected however that the probable em-

ployment of one airship—dirigible balloon or aeroplane—against another will shortly develop very expert "airmanship" and a variety of aerial ordnance and protective apparatus which will be a feature of the next war.

Already types of aerial armament and terrestrial ordnance for use against air craft have been developed, especially by Germany. In aerial armament we learn of patents being taken out for guns and rifles operated by compressed air or other gases devoid of flame, of bombs and bomb throwing devices, of explosive bombs thrown by hand, of aerial torpedos and mines, of drifting kites, parachutes etc. carrying percussive explosives and other devices. On land the Germans have developed various types of automobile mounted aerial guns as large as three-inch calibre and there are various types of naval guns arranged for high angle and vertical fire already mounted on naval warships. The efficacy of guns on fast automobiles is, however, yet to be demonstrated because, although the automobile may be quite as speedy or speedier than the aeroplane or dirigible, say 40 to 60 miles per hour, it is hampered by the topographical features of land, course and conditions of roads, by other traffic and by the obvious fact that it must halt to aim and fire. The same remarks apply to some extent to naval torpedo boats and destroyers, though doubtless, they have much advantage over land ordnance.

If, however, a dirigible balloon is traveling near the surface, even if fast, it becomes a good target for small arms and rapidly handdled stationary artillery if favorably posted. An instance of this occurred in experiments carried out in the June 1910 manoeuvres by United States officers where kites and captive balloons were used at elevations from 200 to 400 yards at ranges of from 500 to 2,000 yards. The opinion of the officers engaged is given thus: "If the aeroplane or balloon is to be rendered immune from crippling by small arms or by artillery fire it will have to be traveling pretty high up. Anything under 500 yards would be dangerous to the machine and its occupants." (U. S. Army and Navy Journal.)

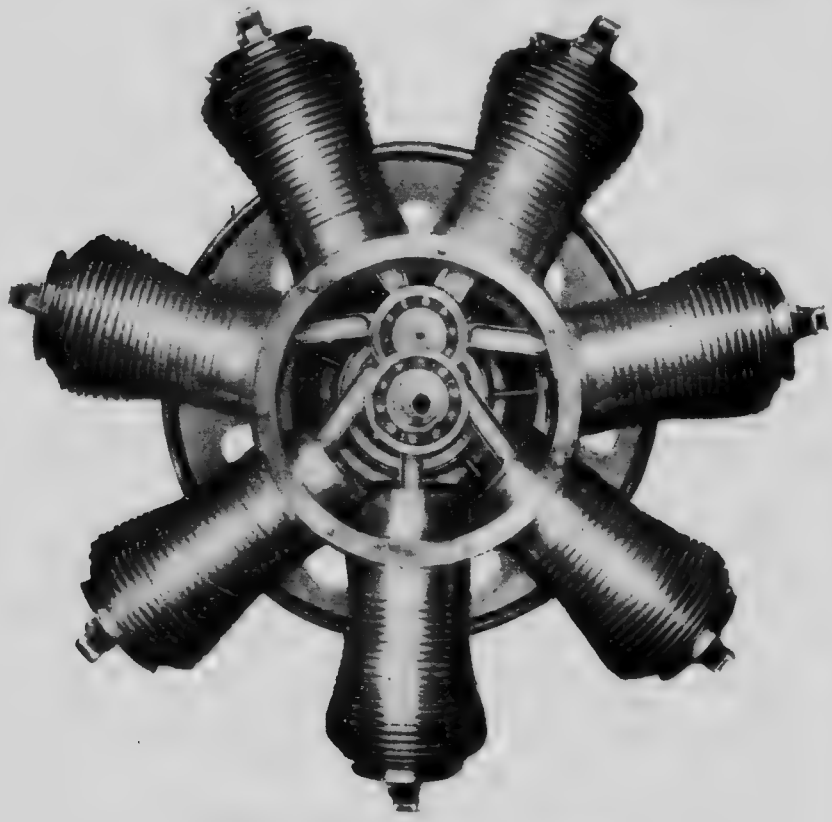
Reconnaissance by Airships.

Much has been said the past few years of the wonderful opportunities opened by aerial navigation for reconnaissance and intelligence work. This is undoubtedly true, and it will be along these lines of usefulness that for some years to come both dirigibles and aeroplanes will be employed. It is needless to point out the ways in which the reconnaissance can be done from airships as the various methods from rapid observation at 50 miles per hour to slow, almost hovering movement sufficient to observe terrestrial details by field glasses, sketch outlines and photograph by telephono lenses can be well appreciated.

It must be remembered, however, that it is very difficult to distinguish objects on the earth at a height above it. Even at 300 feet above the ground, men appear as very small objects; at 3,000 feet, not even the strongest camera lens would bring out details of

infantry in extended order. This can be shown without going aloft in an airship, as for instance, by looking down into a valley from a mountain peak or cliff. Generally speaking, however, the range of vision of an airship above the earth's surface is very much extended; for instance, at 500 feet up a range of 20 miles could be secured and if the day were clear and a strong glass employed the general topographical features could be readily made out.

To show how difficult it is to reconnoitre from above it is interesting to refer to the German army maneuvers in September 1910



INTERIOR OF GNOME ENGINE

Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

where the Red Commander entirely misled the Blue Air Scout (up 3000 feet,) by erecting sham earthworks and placing therein tree trunks in imitation of guns while his real entrenchments were in another locality altogether and more or less masked from view. The result of the deception was quite successful for the Blue lost much valuable time and his attack was seriously compromised.

The French army maneuvers in Picardy in October 1910 brought out numerous performances of airships, especially of aeroplanes.

The machine used for reconnaissance by the Blue army was a Farman bi-plane carrying an aviator and a passenger who was an intelligence officer from the general staff. Its performance will be historic because of the valuable information of the enemy's movements gained in its two flights by observing from a height above 1,500 feet with a success in contrast to the performance at the German manoeuvres and on account of its rapid work. The flights were each of about 30 miles and the time occupied from 50 to 70 minutes. In one case, the report was in the hands of General Picquart, commanding Blue army, within 50 minutes after the landing of aeroplane several miles distant from army headquarters. The contents of reports were exceedingly full and accurate considering the rapid movement, some of the observations recorded being only 2 or 3 minutes apart. As a result of one of these flights the movements of the enemy (Red) were exposed to the aviator's view in a flanking retreat where only a rear guard and cavalry screen were left on the former position; the Blue army was consequently ordered to promptly advance to take the Red movement in flank, which was done with success.

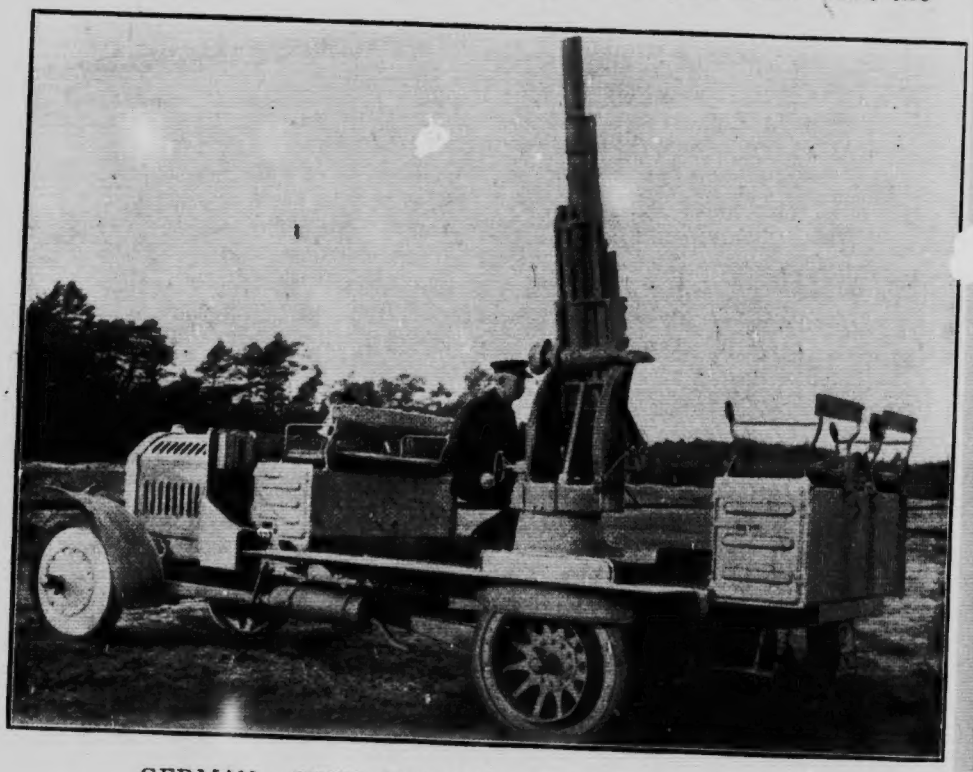
These French manoeuvres have shown that the whole service of reconnaissance can and will be revolutionized by the use of aeroplanes in rapidly obtaining and reporting movements of the enemy, but that the aeroplane or airship cannot—in the near future at least—entirely supplant cavalry for reconnaissance on account of darkness or misty or windy weather. As to vulnerability, it has been observed by British critics of these manoeuvres that, although the enemy had three-inch guns mounted on 40 H.P. motors capable of high angle fire, a rapidly moving aeroplane, owing to its great speed and its power to rise and fall and twist and "jink" is about as hopeless a target for artillery as can be imagined, and a hit will probably be nothing better than a fluke.

In some U. S. manoeuvres held at San Antonio, Texas, the present month, several aeroplanes were used in manoeuvres against field guns. Although at no time within effective range of rifle or the ordinary field guns the report says that the aviator brought in "startlingly accurate reports" as to strength of men, horses and guns and their dispositions. The report concludes that "army officers admit that this operation shows the need of aerial guns and an aeroplane corps in the United States army." A feature of this operation is the statement of the aviator Simon in a Bleriot that the firing of blank form field artillery at short range was so disturbing to the surrounding air that it "perceptibly jarred his aeroplane."

Organization and Training of Aerial Corps.

It is not at all surprising that, with all this progress and the swift application of aerial navigation to uses of warfare as the first employment, the nations are seriously organizing and training aerial corps. Next to the development of the machine and equipment, the training of experienced expert aviators and aeronauts is paramount. This is harder than it seems for the

means of training are limited, are highly expensive, and often produce discouraging results, as have been experienced the past 3 years. The present year, however, sees all the great powers appropriating large sums in their estimates for this purpose. The German Government has planned very large expenditures, and it is now unofficially announced that eleven German universities will, during the summer of 1911, institute lectures on aeronautics and the mechanical principles underlying the flying machine and its operation. The United States has authorized very considerable expenditures in training, and the news just comes that the



GERMAN 3-INCH GUN FOR ATTACKING AIRSHIPS
Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer.*

National Guard of California has authorized the formation of an aerial corps in connection with the Coast Artillery. It is interesting to notice that the British Army estimates for 1911 include a half-million dollars for new dirigibles and aeroplanes and for the expenses of an aeronautic staff. It is stated in newspaper despatches that the British Army will have five dirigible balloons and five aeroplanes available for use the coming summer.

As to training, especially in aeroplane operation, the work of Mr. Curtiss at San Francisco for the U. S. Army and Navy is of special note, as indicating how he instructs novices to handle

a machine. The first operation after mastering the mechanism of machine and engine is to take short hops or jumps of from 50 to 200 feet, but not higher than 20 feet. Then longer jumps are allowed, and then a low flight, skimming the surface or "grass-cutting" as it is called. After this recruits are allowed to fly and manoeuvre, but always over level ground and close to it. Reports say that practical and athletic officers who are accustomed to motoring and sailing learn very rapidly and safely.

As to the attitude of our own Canadian service to this most important branch of military development, it is not for the author to venture to state or suggest. It is to be noted, however, that as the cost of construction and operation of an up-to-date aeroplane is only about one-tenth of that of a dirigible balloon—being say $4,000 or $5,000 in first cost—and the usefulness of the aeroplane is well established, it is to be expected that Canada's first attention will be given to this method of aerial navigation and that a corps of aviators, probably from the Engineers, will doubtless shortly be organized and trained for that purpose.

The relation of the Corps of Guides to this new aerial service when developed is obvious, because as Intelligence officers being trained for reconnaissance duties, they must early become proficient in all the various methods employed in that branch of military work.

Toronto, February 23rd, 1911.

In the preparation of the foregoing the author wishes to state that he has obtained all his information from published records, books and articles on the subject. He has never had the opportunity of either operating any aerial craft or of being a passenger on one. He has, however, been a keen student of the subject of aerial navigation for many years, and in January 1895 when the subject was as yet in its infancy, he prepared a brochure entitled "Aerial Mechanical Flight" and presented it before the Engineering Society of Toronto.

Acknowledgment is made by the author to the following:
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"My Airships," Santos Dumont, 1908.
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And various Articles and Press Despatches appearing in:
"The London Times."
"The New York Herald," and
Various Canadian and American Daily papers supplied by the Associated Press and Canadian Associated Press.